Preparation, chemical composition and nutritional evaluation of locally produced weaning food from cereals and leguminous plants

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ABSTRACT

The composites blends were formulated based on protein basis of the food commodities used yellow corn, soya bean, guinea corn, millet, groundnut cake, dates, Cray fish, ginger and garlic.

Standard procedures recommended by Analytical of Official Analytical Chemists were used to determine the proximate composition, vitamins, minerals, and Amino acids contents Atomic Absorption Spectrophotometer VG Bulk 211 model And Gas Chromatography Mass Spectrophotometer were used to determine the mineral elements and nutritional composition of the locally produced weaning food.

The results showed that moisture, ash, crude fibre, protein, carbohydrate and energy contents of the formulated weaning food were either comparable or higher than the values of the commercial baby food. The vitamins, minerals and amino acids were present in the formulated weaning food. It can be concluded that proper selection and combination of local food stuffs can produce a low-cost and highly nutritive weaning food.

KEYWORDS: weaning food, proximate composition, vitamins, amino acids, Atomic Absorption Spectrophotometer, .Gas Chromatography Mass Spectrophotometer

INTRODUCTION

Malnutrition does not only persist but remains widespread in many developing countries despite abundant varieties of food sources or items. The World Health Organization and UNICEF are very much concerned about this trend. Protein Energy Malnutrition (PEM) and micronutrient deficiencies among infants, children and pregnant women have been shown to be directly and individual associated with more than 50% of all childhood morbidity and mortality in the developing world [1].

The World Health Organization Global Index for child growth and malnutrition based on surveys worldwide shows that the prevalence of under nutrition as a result of wasting, stunting and underweight is very predominant in Africa [2].

Results of the food consumption and nutrition survey conducted by [3] showed a steep increase in the incidence of child wasting between 6-12 months, which is the period of complementary feeding for most children Breast milk satisfies the nutrient and energy requirements of the infant for the first 4-6 months; subsequently, the nutritional composition of the breast milk increasingly becomes inadequate to meet the infant's requirement. Therefore, to be able to meet the changing requirements of the infant, there is the need to supplement the breast milk with a nutritious diet, which could be a proprietary formula or locally prepared one, while breast feeding continue for at least 2 years Thus, there is a gradual shift from breast milk feeding to semisolid or solid food complementary feeding [4].

Previous studies have shown that proper combination, mixing and blending of certain cereals and legumes have the potential to provide alternative nutrients which serves as complementary food for infants [5, 6].

Research has shown that PEM (Protein Energy Malnutrition) in children is the result of frequent use of maize pap (koko) and millet gruel during the weaning period; being weaning foods which are very low in good quality proteins. Kwashiorkor, a protein deficiency syndrome, a major debilitating disease of children in many developing countries is significantly due to low purchasing power, poverty and ignorance of the majority of the population which denies them access to adequate weaning food [7].

When the diets are based mainly on cereals and are inadequate especially in the younger children marasmus becomes commoner than Kwashiorkor. Marasmic-kwashiorkor results from mixtures of deficiencies that cause either. In most developed societies, nutrient fortified cereals are the first complementary foods introduced to the infant, followed by fruits, vegetable, and meat products. In developing countries, although a number of convenient fortified proprietary formulas are available, they are often too expensive and out of the reach of most families. The use of home-based complementary food that can be readily prepared, available, and affordable, is one feeding option that has been recommended to stem the deleterious effect of malnutrition in infant and young children [8]. The use of high nutrient dense food stuffs such as cereal, legumes, vegetables and animal food products to prepare complementary foods for infants and children has been suggested by a number of researchers [9]. Cereals that are generally used are known to be relatively low in lysine and tryptophan, but fair in sulphur – containing amino acids (methionine and cysteine). Legume-proteins should complement the protein in cereal grains since the chemical and nutritional characteristic of legumes make them natural complements to cereal-based diets.

Dietary diversification, supplementation and fortification of locally available foods could also result in improved micro- nutrient intake of infants and younger children during complementary feeding period. This study was part of an exploratory effort on the improvement on nutritional quality of traditional complementary food. It was designed to use staple foods to formulate composite blends that can provide the needed nutrients for nourishing infants and children and are readily available and affordable to both rural and urban poor mothers in particular [10].

MATERIALS AND METHODS

Sample Collection

Yellow corn, soya beans, dates, Cray fish, groundnut, millet, ginger, garlic and Nestle Cerelac baby food were purchased from Owode market, Ede North Local Government Area, of Osun State, Nigeria.

Complementary food formulation

The cereal grains, yellow corn, millet, guinea corn (Sorghum bicolar) were separately washed with clean water and air dried for 72 hours. The soya beans (Glycine max) were thoroughly washed, air dried and fried until it turned brown. The groundnuts were also fried and the back peeled off. The crayfish was sorted and cleaned. The dates fruits were crushed to remove the seed, washed with clean tap water and air-dried for 72hours. The dried groundnut and soya beans, dried millet, guinea corn, yellow corn, dates fruit and crayfish were thoroughly blended and mixed using milling grinding machine, sieved into fine smooth homogeneous powder and stored in an air-tight container prior to analysis.

Proximate determination

Proximate analysis

This was carried out on locally produced weaning food in triplicates.

Moisture, ash, crude protein, crude fat, crude fibre, carbohydrate and energy were determined by the recommended methods of Association of Official Analytical Chemists [11, 12].

Mineral content determination

2g of the dried samples were used in the determination according to the method of. The sample was ignited in a muffle furnace at a temperature of 550°C. The ash was dissolved in 10 mL of 5M HCl. Acid digestion of the ash was carried out on a steam plate and the digested sample was carefully washed with distilled water and filtered using Whatman filter paper number 1 into a 50mL volumetric flask and made up to mark. The samples and blanks were then directly analyzed for the different minerals (Na, Ca, K, Zn, Fe, P and I using the Atomic Absorption Spectrophotometer (Perkin-Elmer Analyst 700 spectrophotometer. Phosphorous was determined spectophotometricallyusing vanadomolybdate method [11].

Determination of amino acids

Amino acid composition of samples was measured on hydrolysates using an amino acid analyzer (Sykam-S7130) based on high performance liquid chromatography technique. Sample hydrolysates were prepared following the method of Moore and Stein [13]. 200mg of sample were placed in a hydrolysis tube. Then 5ml of 6M HCl were added to sample inside the tube, tightly closed and incubated at 110^{0}C for 24hrs. After incubation, the solution was filtered and 200mL of the filtrate was evaporated to dryness. The hydrolysates were reconstituted in 20mL of 0.1M HCl, citrate buffers of pH, the same standard applied to amino acid. An aliquot of 150 uL of sample hydrolysate was injected in a cation separation column at 130^{0}C. Ninhydrine solution and an ellուent buffer (the buffer system contained sodium acetate (90%) and acetonitrile (10%) were delivered simultaneously into highly temperature reactor coil (16m length) at a flow rate of 0.7mL.min^{-1}. The buffer ninhydrine mixture heated in the reactor at 130^{0}C for 2min to accelerate chemical reaction of amino acids with ninhydrine. The products of the reaction mixture were detected at wavelengths of 570nm and 440nm on a dual channel photometer. The amino acid composition was calculated from the areas of standards obtained from the integrator and expressed as percentages of the total protein.

Determination of Fatty acids

50g of the extracted fat content of the sample was saponified (esterified) for five (5) minutes at 95^{0}c with 3.4ml of the 0.5M KOH in dry methanol. The mixture was neutralized using 0.7M HCl. 3ml of the 14% boron trifluoride in methanol was added. The mixture was heated for 5 minutes at the temperature of 90^{0}c to achieve complete methylation process. The Fatty Acid Methyl Esters was extracted from the mixture with redistilled n-hexane. The content was concentrated to 1ml for gas chromatography analysis and 1ul was injected into the injection port (injector) of GC. The temperature was said to be higher than the boiling points of the sample mixture to allow easy vaporization. The vaporized sample was then mixed with the inert gas mobile phase to be carried the gas chromatography column to be separated. Mixtures are separated based on their ability to absorb on or bind to the stationary phase.

The components of the mixture reached the detector at different times. Due to differences in the time, they are retained in the column. The component that is retained for the shortest time in the column was detected first. The component that is retained the longest time in the column was detected last. Signal was sent to chart recorder by the detector which results in a peak on the chart paper. The component that was detected first was recorded first. The component that was detected last was recorded last

Vitamin determination

10ml of standard salts of fat soluble Vitamin A.D, E, K and water soluble B_1, B_2, B_3, $B_{6,}$ and B_{12}) were weighed into 25 mL volumetric flask, dissolved and made up to mark with the buffer solution and labeled as stock.4ml of standard stock solutions were transferred into 25ml amber volumetric flask, made up to mark with the buffer solution, vortexed and labeled as intermediate mixed stock. The intermediate mixed stock solution was used to carry out serial dilutions by pipetting 1ml, 2ml, 3ml, 4ml and 5ml of this solution into 5 different10ml volumetric flasks and made up to mark vortexed buffer solution and labeled. as

mixed working standards serially. The mixed working standards were transferred into vials with a syringe and micro filter for each working standard.
The working standards and the samples were analyzed using HPLC. The above analyses were performed on both the formulated baby food sample and the control (Nestle Cerelac).

Results and Discussion
Table 1 presented the proximate composition of locally formulated and commercial weaning food (cerelac).The moisture content of locally formulated weaning food 5.75±0.30 % was higher than the commercial weaning food 2.51+0.029 %.The value was in agreement with 5.75 % reported for composite blend [14]. However, the value fall within the recommended value 5-10 % by Protein daily Allowance (PDA). The low moisture content reported in this work showed that the locally formulated weaning food was less prone to microbial attack during storage thus prolonging the shelf-life of the weaning food. The ash content is an indication of the mineral composition preserved in the food materials [15, 16].. The ash content (5.60±0.30 %) was higher than 3.00± 0.01[a] % reported for commercial weaning food and 1.80 % low-cost infant food reported by [14] and 3.59% for baby food [17]. This showed that the locally formulated weaning food contained high amount of nutritive minerals. Generally, infants require high quality protein to prevent the occurrence of protein malnutrition that is responsible for stunted growth [18]. The protein content 17.50±0.30 % in this study was slightly higher than 15.50±0.05 % for commercial baby food and 16.29±0.22 % for low-cost infant diet formulated food [14]. This study reported high amount of crude protein in the locally formulated weaning food which will be able to meet the 13-14 g RDA [6].The value also fall within the recommended limit of 20.00 by PAG.
The crude fibre content 2.60±0.25[a] % in locally formulated weaning food was a bit lower than the commercial baby food 4.50± 0.05 %. .However, this value was slightly higher than 2.40 ± 0.05 % reported for low-cost infant diet [14]. However, the value fell within 5.00 permissible limits (PAG). Dietary fats increase the palatability of food by absorbing and flavours [19]. The fat content 15.60±0.20 % was higher than the commercial baby food 10.00± 0.01 % and 11.30±0.02 % reported for low-cost infant diet [15]. This high fat content suggested that the shelf life of locally formulated weaning food may decrease resulting in high susceptibility to oxidative rancidity. Carbohydrate content contributes to the bulk of the energy of the formulation. The carbohydrate content in locally formulated weaning food 58.70±0.50 % was slightly lower than the commercial baby food 65.00± 0.05 % and 62.46±0.5.% for low- low-cost infants diet [14].The high carbohydrate yield of locally formulated weaning food makes them ideal for babies since they required it for their rapid growth. However, this value was in close range with the recommended value of 65.00% by PAG. Adequate energy is required to promote linear growth and prevent energy malnutrition in infants. The energy value of locally formulated weaning food 444.80±0.50 % was a bit higher than commercial baby food 410.00± 0.02% and 416.7±0.81 % reported for low infant baby diet [14].

Table 1: Proximate composition

Nutritional components	Sample A	Sample B	Sample C	PAG
Moisture content (%)	5.75±0.30[a]	2.51+0.029[a]	5.75±03[a]	5-10
Ash content (%)	5.60±0.30[a]	3.00± 0.01[a]	1.8±0.22[a]	≤ 5
Protein content (%)	17.50±0.30[a]	15.50±0.05[a]	16.29±0.22[a]	20
Crude fiber (%)	2.60±0.25[a]	4.50± 0.05[a]	2.4±0.50[a]	<5
Fat content (%)	15.60±0.20[a]	10.00± 0.01[a]	11.30±0.02[a]	10
Carbohydrate (%)	58.70±0.50[a]	65.00± 0.05[a]	62.46±0.5.0[a]	65
Energy values (%)	444.80±0.50[a]	410.00± 0.02[a]	416.7±0.81[a]	

Sample A: Locally made weaning food (Tom Brown)
Sample B: Commercial weaning food (Cerelac)
Sample C: reported local weaning food [14].

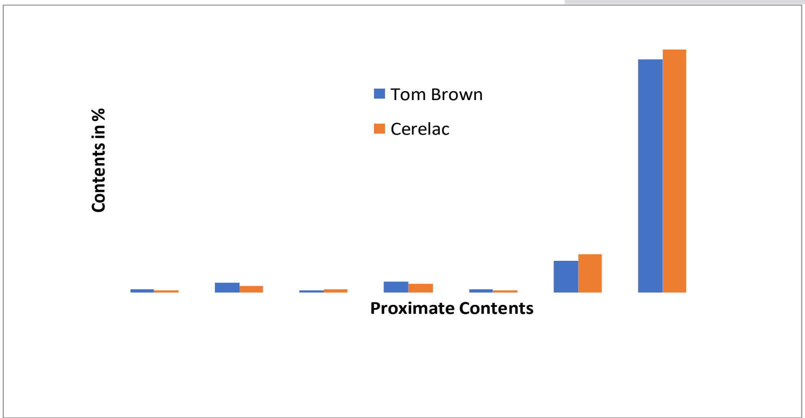

Fig.1: Proximate composition contents of Tom Brown and Cerelac

Mineral Contents Determination

Table 2: Mineral composition of tom brown and Cerelac

Mineral component (mg/100g)	Sample A	Sample B	Sample C	USRDA
Sodium, Na	176 + 0.53[a]	145+ 0.5[a]	174.7 + 0.72 [a]	120-225
Calcium, Ca	625 + 0.82 [a]	600+ 0.01 [a]	381.0 + 1.72 [a]	210-600
Potassium, K	620 + 0.50 [a]	635+ 0.05[a]	81.55 + 0.90 [a]	500-1000
Zinc, Zn	9.0 + 0.20 [a]	7.0+ 0.25 [a]	31.0 + 0.98 [a]	5-10
Iron, Fe	16 + 0.50 [a]	10 + 0.5 [a]	8.01 + 1.39 [a]	6-15
Phosphorus, P	320 + 0.20 [a]	400+ 0.02 [a]	70.0 + 0.01 [a]	270-400
Iodine, I	40 + 0.50 [a]	20 + 0.60 [a]	-	40-60

Note: Sample A = Locally made baby food (Tom Brown)
Sample B = Commercial weaning food (Cerelac)
Sample C = Control Sample [14].

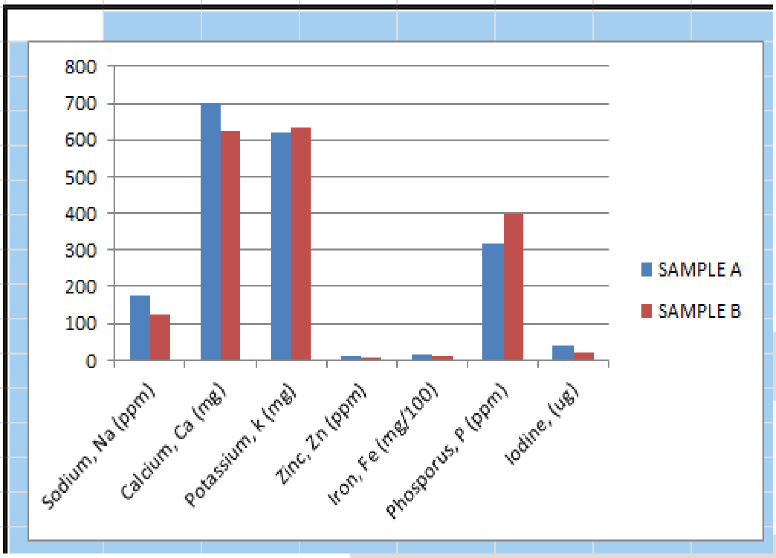

Table 3 presented the results of mineral analyses for locally formulated weaning food and commercial baby food (cerelac).Minerals are vital for the overall mental and physical well-being and are important constituents of bones, teeth, tissues, muscles, blood and nerves cells [20]. They serve as cofactors for many physiological and metabolic functions [21]. Sodium is a mineral that body must have in order to function properly. It controls body blood volume and blood pressure. It is the mineral that carries electrolytes [22]. The sodium content1 76 + 0.53 mg/100g was significantly higher than commercial baby food (145mg/100) and slightly higher than 174.7 + 0.72 % reported for low cost-infants diet [14]. However, the value was in agreement with United State Recommended Daily Allowances (USRDA).Potassium is the third most abundant mineral in the body. It helps the body to regulate fluid, send nerve signal regulates muscles. The potassium content 620 + 0.50 % in locally formulated weaning food was a bit lower than 635+ 0.05-% reported for commercial baby food. However, this value was significantly higher than 81.55 + 0.90 % reported for low-cost infant diet [14]. Calcium is the most abundant minerals in the body. It regulates many cellular processes and has important structural roles in living organisms. The values of calcium obtained in this study (625 + 0.82. mg/100g) were slightly higher than 600+ 0.01mg/100g) for commercial baby food and significantly higher than 381.0 + 1.72 mg/100g reported for low-cost infant diet [14]. However, the value was slightly above the recommended value 210-600mg/100g (USRDA) .Iron is a key mineral responsible for growth and development. It produces hemoglobin that helps red blood cells carry Oxygen from the lungs to the rest of our body [23]. The content of iron 16 mg/100g in locally formulated weaning food was higher than 10 mg/100g for commercial baby food and 8.01 + 1.39 mg/100g reported for low-cost infant diet [14]. However, the value was in close range with the recommended value 6-15 mg/100g (USRDA). The addition of legumes to cereals in locally formulated weaning food could be responsible for higher iron content since it is low in cereals but rich in legumes [24]. The zinc content 9.0 + 0.20 mg/100g in locally formulated weaning food was higher than 7.0+ 0.25 mg/100g in commercial baby food. This value was significantly lower than 31.0 ± 0.98 mg/100g reported for low-cost infant diet [14] (Enoch *et al*, (2019).However, this value was in agreement with USRDA permissible limit (5-10 mg/100g). Minerals such as iron and zinc are low in cereals but very rich in legumes [25]. Therefore, the addition of legumes to cereals in locally formulated weaning food in this study might be responsible for higher iron and zinc content. The body requires iron for production of red blood cells and also on regular supply as obtained in this present study could help in reducing the prevalence of stunted growth caused by limited zinc supply [25].Phosphorus is a mineral that makes up 1% of a person's total body weight. It is the second most abundant mineral in the body. It is needed for the body to produce carbohydrate, fats and protein for growth [26].

The Phosphorous content 320 ± 0.20 mg/100g was lower than 400± 0.02 mg/100g for commercial baby food and significantly higher than 70.0 ± 0.01 mg/100g reported for low-cost infant diet [14]. However , the value for locally formulated weaning food was within the close range of 270-400 mg/100g recommended value by USRDA.

Iodine is an essential nutrient contributing to the normal development of central nervous system. The Iodine content (40 mg/100g) for locally formulated weaning food was significantly higher than the commercial baby food (20mg100g). However, this value was in agreement with 40-60 mg/100g URSDA permissible level.

The result indicated that the locally formulated weaning food was made from local contents of high quality being fortified with dates and ginger which are rich in vital minerals for the overall mental and physical well-being and are important constituents for growth, teeth, tissues, blood and nerves cells.

Vitamins are group of organic compounds that are important for normal growth and nutrition and are required in small quantities in the diet because they cannot be synthesis by the body [27].

Table 3 showed the Vitamin composition for locally formulated weaning food as; Vitamin A (1310 mg/100g), Vitamin B_1 0.80 mg/100g, Vitamin B_2 (0.47 mg/100g), B_6 (42.60 mg/100g), B_{12} 1.00 mg/100g, B_7 28.0 mg/100g, Vitamin C 28.0 mg/100g, Vitamin D, 189. 60 mg/100g, and Vitamin E, 8.34 mg/100g and commercial baby food were ; Vitamin A (1300 mg/100g), Vitamin B_1 (0.6 mg/100g), Vitamin B_2 (0.45 mg/100g), B_{12} (1.10 µg/100g), B_6 (0.3 mg/100g), B_7 (7.00 mg/100g), B_9 (40.00 mg/100g), Vitamin C (65 mg/100g), Vitamin D (108.0 mg/100g), and Vitamin E (6.80 mg/100g).Also, for low-cost infant diet, vitamin D (0.28mg/100g), vitamin B_2 (0.02mg/100g),vitamin B_6 (0.21mg/100g), vitamin B_{12} (0.07mg/100g), vitamin C (3.92mg/100g) and vitamin A (448mg/100g). It was discovered that Vitamin B_1 (0.8µg/100g), B_2 (0.47mg/100g), B_6 (0.54mg/100g), B_9 (42.60mg/100g), A (1310 mg/100g), D (189.60 mg/100g), and E (8.34 mg/100g) were very high in locally formulated weaning food than commercial baby food and low-cost infant diet reported by [14]. Vitamin B6 is involved in homocystein metabolism [28]. Vitamin B_6 0.54±0.20 mg/100g) was higher than commercial baby food 0.30±0.702 mg/100g and significantly higher than 0.21±0.10 mg/100g reported for low-cost infant diet [14]. However, the value fall within USRDA 0.3 – 1.0 mg/100g permissible limit. Vitamin C (28.0mg/100g) content in locally formulated weaning food was lower than commercial baby food 65.00±0.85mg/100g and low-cost infant diet 3.92±0.17 mg/100g [14]. This might be due to fortification of commercial baby food with additional vitamin C. However, this value falls within USRDA permissible limit of 20 – 40 mg/100g.

Table 3: Vitamin Contents

Vitamins	Sample A (Tom Brown)	Sample B (Cerelac)	Sample C	USRDA
B6 (mg/100g)	0.54±0.20[a]	0.30±0.702[a]	0.21±0.10[a]	0.3 – 1.0
B1 (mg/100g)	0.80±0.10[a]	0.60± 0.01[a]	0.28 ±0.01[a]	0.3 – 0.7
B2 (mg/100g)	0.47±0.01[a]	0.45± 0.05[a]	0.02±0.01[a]	0.4 – 0.8
B9 (µg/100g)	42.60±0.02[a]	40.00± 0.5[a]	-	25 - 50
B12 (mg/100g)	1.00±0.20[a]	1.10± 0.05[a]	0.07±0.04[a]	0.3- 07
B7 (µg/100g)	5.86±0.40[a]	7.00± 0.01[a]	-	10 – 20
C (mg/100g)	28.0±0.02[a]	65.00± 0.85[a]	3.92±0.17[a]	20 - 40
D (mg/100g)	189.60±0.05[a]	180.00± 0.5[a]	-	280 – 400
E mg/100g)	8.34±0.20[a]	6.80 ± 0.05[a]	-	-
A(mg/100g)	1310±0.01[a]	1300 ± 0.52[a]	4.48±0.03[a]	1500

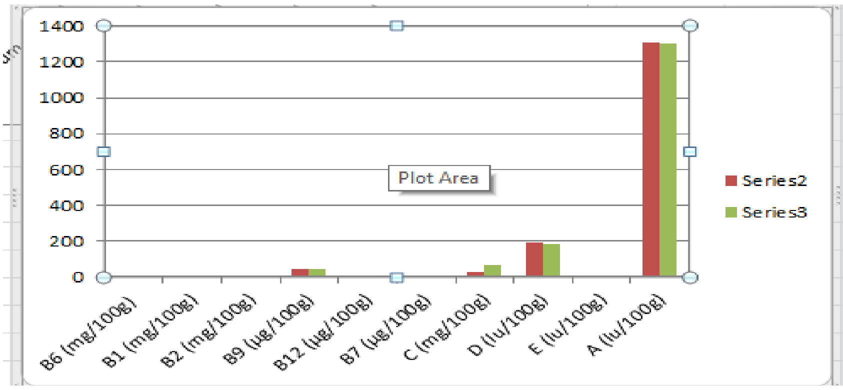

Figure 3: Vitamins contents in tom brown and cerelac

Determination of amino acid

Table 4: Amino acid contents of locally produced baby food (tom brown) and commercial baby food (cerelac)

Essential amino acids	Sample A	Sample B	Sample C	FAO Ref values
Lysine	3.43±0.059^{a}	4.86 ± 0.32^{a}	4.14±0.03^{a}	4.4
Valine	3.83 ± 0.03^{a}	5.49± 0.01^{a}	4.03± 0.01^{a}	7.2
Isoleucine	3.88± 0.01^{a}	4.25 ± 0.2^{a}	3.6± 0.02^{a}	4.80
Thyronine	3.56± 0.05^{a}	4.18± 0.05^{a}	3.05 ± 0.00^{a}	7.80
Phenylanine	5.35± 0.82^{a}	4.77 ± 0.65^{a}	3.37±0.59^{a}	2.60
Methionine	1.63± 0.28^{a}	2.31± 0.10^{a}	2.24 ± 0.02^{a}	2.20
Arginine	6.30± 0.58^{a}	4.02 ± 0.20^{a}	5.68± 0.62^{a}	3.60
Leucine	7.08± 0.85^{a}	8.32± 0.89^{a}	7.18± 0.65^{a}	4.20

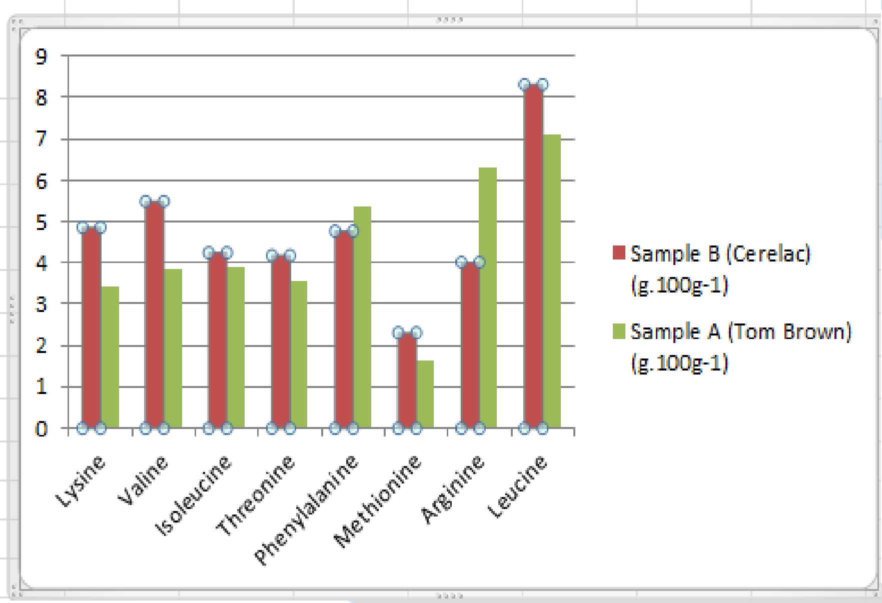

Figure 4 : Essential amino acids content in Tom brown and Cerelac

Non-essential amino acids	Sample A	Sample B	Sample C	FAO Ref values
Glycine	3.34±0.20^{a}	4.15±0.05^{a}	3.99 ±0.01^{a}	4.00
Serine	4.63± 0.02^{a}	3.45±0.02^{a}	2.7±0.01^{a}	7.01
Proline	3.83± 0.20^{a}	3.05±0.01^{a}	3.04±0.02^{a}	5.50
Glutamic	12.78± 0.50^{a}	7.04±0.01^{a}	12.72± 0.05^{a}	14.30
Aspartic	6.70± 0.20^{a}	4.00±0.02^{a}	8.68±0.05^{a}	9.00

Fig 5: Non-essential amino acid content in tom-brown and cerelac

Table 5 : Determination of fatty acid contents of locally made baby food (tom brown) and commercial baby food (cerelac)

Fatty Acid	Sample A (Tom Brown)%	Sample B (Cerelac)%	Sample C%
Linolenic	1.00 + 0.5 [a]	0.2 +0.01[a]	1.21 + 0.1[a]
Lauric Acid	0.13 + 0.02 [a]	0.19+0.05[a]	2.12 + 0.16 [a]
myristic acid	0.43+ 0.05 [a]	0.00 +0.00[a]	0.06 + 0.01 [a]
Falnitic Acid	15.48 + 0.53 [a]	0.00 +0.00[a]	3.42+ 0.31 [a]
Stearic Acid	2.89+0.20[a]	0.50±0.01[a]	0.15+ 0.04 [a]
Oleic Acid	26.23+050[a]	3.65±0.05[a]	1.21+ 0.13 [a]
Linoleic Acid	3.20+0.51[a]	2.60±0.02[a]	0.45+ 0.03 [a]
Arachidonic Acid	0.12+0.01[a]	0.00±0.00[a]	0.03+ 0.009 [a]

Values are mean of triplicate determination, Sample A; locally formulated weaning food
Sample B: Commercial baby food, Sample C- control sample [29].

Amino acids are building blocks of our cellular machine in the form of proteins & protein complex. Essential amino acids produce energy and build proteins and some form neurotransmitter and hormones. Protein Energy Malnutrition (PEM) is a continuous challenge in Nigeria because of the low quality of protein as a result of deficiency in essential amino acids which is commonly found in plant-based single diets [30, 31].

However, the result of Amino acid contents obtained in Table 4 revealed the presence of all the amino acids in the locally formulated weaning food, commercial baby food as well as low-cost infants diet [14] were in close range.

The relatively high contents of unsaturated fatty acids are known to be desirable in food compared with their saturated fatty acids because they help lowering cholesterol and improve heart health [32]. Oleic acid which is the mono unsaturated fatty acid playing a role of anti-inflammatory fatty acid, and in the activation of different pathways of immune competent cells [33]. Table 4 showed that oleic acid content in locally formulated weaning food 26.23+050 % was significantly higher than 3.65±0.05% reported for commercial baby food and 1.21+ 0.13 % for complimentary food fortified with soya bean [29].

Also, the linoleic acid value for locally formulated weaning food (3.2%) was higher than commercial baby food (2.60%) and for complimentary food fortified with soya bean 0.45% [29]. The linolenic acid content for locally formulated weaning food 1.00% was higher than 0.2% reported for commercial baby food. This value was slightly lower than (1.21%) for complimentary food fortified with soya bean [29]. However, this value was in close range with

Conclusion

It can be concluded that locally formulated weaning food (Sample A) has remarkable amount of protein, fats, energy value and ash content, hence will serve as a good source for building body cells, energy, aiding digestion, enhances adequate growth and development in children less than 2 years. It is also a good source of essential minerals such as Na, Ca, Zn, K, Fe, P and I which are vital for the overall mental and physical well-being of infants. The study also compared amino acids contents, vitamins content and fatty acids contents in locally formulated weaning food (Sample A), commercial baby food (Sample B) and reported local weaning food (Sample C). Base on this study, both samples have moderate proportion of amino acids and vitamins. However, the fatty acids present in locally formulated weaning food (Sample A) were higher than the commercial baby food thus enhancing the development of brain, nerves and eyes... Therefore, locally made weaning food prepared from natural materials (fruits and plant) has appropriate nutritional properties as recommended by [34].

Reference

[1]. SCN (2004). Nutrition for improved development outcomes of 5th report on the world nutrition situation standing committee on Nutrition (SCN) Geneva.

[2]. UNICEF. (2007). The state of the world's children 2008: *Child survival* (Vol. 8). Unicef.

[3]. IITA (2004). Summary proceedings of the stakeholder meeting for the project on Micronutrient Enrichment of maize and plantain in Nigeria: A sustainable approach to mitigate hidden hunger. *International Institute for Tropical Agriculture* 7-8th September 2004.

[4]. Keeley, B., Little, C., & Zuehlke, E. (2019). The State of the World's Children 2019: *Children, Food and Nutrition--Growing Well in a Changing World*. UNICEF.

[5]. Fernadez DR, Vanderjagt DJ, Williams M, Huang YS, Chuang LT,Millson M, Glew H (2002). Fatty acd, amn acid and trace mneral analyses of five weaning foods from Jos, Nigeria. *Plant Foods for Human Nutrition* (Dorddrecht,Netherlands), 57(3-4), 257-274.

[6]. Solomon M. (2005). Nutritive value of three potential complementary foods based on cereals and legumes. African *Journal of Food, Agriculture, Nutrition and Development*, 5(2), 1-14.

[7]. Hanson, J. L., Hair, N., Shen, D. G., Shi, F., Gilmore, J. H., Wolfe, B. L., & Pollak, S. D. (2013). Family poverty affects the rate of human infant brain growth. *PloS one*, 8(12), e80954.

[8]. Neufeld, L. M., Beal, T., Larson, L. M., & Cattaneo, F. D. (2020). Global landscape of malnutrition in infants and young children. *Global Landscape of Nutrition Challenges in Infants and Children*, 93, 1-14.

[9]. Omoruyi F, Osagie U.A, and Adamson I. (1998). Blood Protein and tissues enzymes in malnourished rats rehabilitated with corn-crayfish-protein diet. *Bioscience Research Communications* 6-8.

[10]. AOAC (2005) Official methods of Analysis 18 ed. *Association of official Analytical chemist*, Washington.

[11]. AOAC.(1990). Official Methods of Analysis. *AOAC Pub; Virginia, U.S.A.* 1(15).

[12]. Picciano, M. F., Dwyer, J. T., Radimer, K. L., Wilson, D. H., Fisher, K. D., Thomas, P. R., ... & Marriott, B. M. (2007). Dietary supplement use among infants, children, and adolescents in the United States, 1999-2002. *Archives of pediatrics & adolescent medicine*, 161(10), 978-985.

[13]. Kaur, L., Astruc, T., Vénien, A., Loison, O., Cui, J., Irastorza, M., & Boland, M. (2016). High pressure processing of meat: Effects on ultrastructure and protein digestibility. *Food & function*, 7(5), 2389-2397.

[14]. Joel, E. B., Mafulul, S. G., Kutshik, R. J., Tijjani, H., Gonap, B. J., Auta, B. L., ... & Ekundayo, A. A. (2019). Nutrient composition of a low-cost infant's diet formulated from five locally available foodstuffs in northern Nigeria. *International Journal of Biological and Chemical Sciences*, 13(3), 1411-1419.

[15]. Omotosho, O.T (2005).Nutritional , functional properties and antinutrients composition of the Larva of Crinaforda(westwood). *Journal Zhejang University of Science*, 7(1), 51-55.

[16]. Nnamani C.V., Osadabe, H.,O., Agbatutu, A, (2009). Asseesment of nutritional values of three undertlzed ndiigenous leafy vegitable of Ebonyi State, Nigeria. *Africa Journal of Biotechnology.* Vl, 8(9), 23212324.

[17]. Onyedika, N. C., Calvin, N. N., Joseph, A., & Abdullahi, R. M. (2019). Quality assessment of baby food produced from cereals enriched with date palm. Science *World Journal*, 14(1), 28-31.

[18]. Okonjibola ET. (2017). Synthesis of high quality complementary food from locally available crops. *Global Journal of Food Science and Technology*, 5(3), 251-257.

[19]. Anilia, B.S., Akpan .,E.J, Okon and Umoren, I.U (2006). Nutritive and Anti-nutritive of valuation of sweet potatoes leaves. *Pakistan Journal of Nutrition*, 5, 166-168.

[20]. KO, S., CO, O., & O, E. O. (2010). The importance of mineral elements for humans, domestic animals and plants-A review. *African journal of food science*, 4(5), 200-222.

[21]. Schwartz, C., Chabanet, C., Szleper, E., Feyen, V., Issanchou, S., & Nicklaus, S. (2017). Infant acceptance of primary tastes and fat emulsion: Developmental changes and links with maternal and infant characteristics. *Chemical senses*, 42(7), 593-603.

[22]. Huan, L., Jin-Qiang, W., & Qing, L. (2020). Photosynthesis product allocation and yield in sweet potato with spraying exogenous hormones under drought stress. *Journal of Plant Physiology*, 253, 153265.

[23]. Tandoğan, B., & Ulusu, N. N. (2005). Importance of calcium. *Turkish Journal of Medical Sciences*, 35(4), 197-201.

[24]. Briguglio, M., Hrelia, S., Malaguti, M., Lombardi, G., Riso, P., Porrini, M., ... & Banfi, G. (2020). The central role of iron in human nutrition: from folk to contemporary medicine. *Nutrients*, 12(6), 1761.

[25]. Micha, R., Shulkin, M. L., Penalvo, J. L., Khatibzadeh, S., Singh, G. M., Rao, M., ... & Mozaffarian, D. (2017). Etiologic effects and optimal intakes of foods and nutrients for risk of cardiovascular diseases and diabetes: systematic reviews and meta-analyses from the Nutrition and Chronic Diseases Expert Group (NutriCoDE). *PloS one*, 12(4), e0175149.

[26]. FAO/WHO, (2001).Human Vitamins and Mineral Requirements. Human Vitamins and Minerral Requirements, 303, DOI: *https://d.org/10.1016/B978-0-323-06619-8.10013-1*

[27]. Calvo, M. S., Moshfegh, A. J., & Tucker, K. L. (2014). Assessing the health impact of phosphorus in the food supply: issues and considerations. *Advances in Nutrition*, 5(1), 104-113.

[28]. Alexander, J., Tinkov, A., Strand, T. A., Alehagen, U., Skalny, A., & Aaseth, J. (2020). Early nutritional interventions with zinc, selenium and vitamin D for raising anti-viral resistance against progressive COVID-19. *Nutrients*, 12(8), 2358.

[29]. Stuart J.M, Derek L, lan, F.W.M, Zoe, L.C., Ani , K,M, Malcoim, J.L, Jonathan, G(2004). Folate, homocytein, endothelia function and cardiovascular disease. *Journal of Nutritional Biochemistry*, 15, 64-79.

[30]. Akinsola, A., Idowu, M., Oke, E., Idowu, O., & Laniran, A. (2017). Nutritional evaluation of maize-millet based complementary foods fortified with soybean. *Annals. Food Science and Technology*, 18(2), 173-182.

[31]. Temple V.J., Badamosi E.J, Ladeji O and Solomon M (1996). Proximate chemical composition of three locally formulated complementary foods. *West Afr. J. Biol Sci* 5, 134-143

[32]. Anigo, K. M., Ameh, D. A., Ibrahim, S., & Danbauchi, S. S. (2009). Nutrient composition of commonly used complementary foods in North western Nigeria. *African Journal of Biotechnology*, 8(17).

[33]. Belury, M. A., Ros, E., & Kris-Etherton, P. M. (2022). Weighing Evidence of the Role of Saturated and Unsaturated Fats and Human Health. *Advances in Nutrition*, 13(2), 686-688.

[34]. Carrillo Pérez, C., Cavia Camarero, M. D. M., & Alonso de la Torre, S. (2012). Role of oleic acid in immune system; mechanism of action; a review. *Nutrición Hospitalaria*, 2012, v. 27, n. 4 (julio-agosto), p. 978-990.

[35. Yngve, A. M. (1990). IBFAN (International Baby Food Action Network) promotes breast feeding and infant survival. *Jordemodern*, 103(3), 66-69.